ABSTRACT

Solution of mechanical design problems like materials handling systems' design, ship systems and air craft systems formulation, vehicular design, and thermal power plant design etc , calls for a systematic approach with series of steps in the design process Of these the preliminary design which forms the early stage of design process is the most critical part The effort put in here decides the cost, quality, and time needed for the total development of the system/product This is a strong motivating factor for research in design automation Preliminary design is considered herein as a type of conceptual design addressing selection and elaboration of components and their synthesis based on functional requirements and satisfying a few constraints It also includes certain preliminary design calculations for sizing the components and sub-systems without getting into details

In this thesis a computational model called EXPSYS has been developed for automating preliminary design of mechanical systems A general methodology has been proposed through this model The overall function is first decomposed into sub-functions on qualitative basis and in a sequence to maintain logical relationships Design constraints are added to these sub-functions on a selective basis and matched with those of physical devices and components

Keeping the above features in view, the knowledge representation for decision making process is organized as a sequence of nodes Each node represents a logical situation/ circumstance/scenario, having input variables whose values range between prescribed minimum and maximum Particular combination of input variables is processed by the logic of the node to yield specific output variables Functions/Sub-functions and constraints are therefore selectively represented as input variables of each node with particular combination of these yielding a specific output variable As we proceed

from one node to another, functions and constraints together configure components/ sub-systems at each node at different levels of abstraction and finally narrow in on a solution

One of the good features of the algorithm is that it can be run in training mode In case the decision making process of the system yields wrong results, the system can be interactively trained to identify the correct outcome at a node for a given set of values of input variables The system has additional features namely, a computation engine for suggesting reliable design parameters/choices at a macro level and template for presenting the design output in the form of a technical report

An illustration of the computational model described above is given by applying the algorithm to the preliminary design of a piping system The task of selecting essential equipments and fittings for a piping system of a power plant is one of the key aspects for designing a power plant This requires a specialized knowledge and a clear visualization of piping, valves and other equipments The computer model generates the specification of each equipment selected followed by interconnecting pipelines with all necessary fittings as a design output In view of the limited knowledge base the system is capable of designing lubricating oil and fuel oil system for steam turbine power plant and diesel engine power plant However, the knowledge base can be added in a modular fashion without affecting the existing knowledge base so that the system can be extended to include other piping systems as well as other thermal plants like gas turbine etc EXPSYS thus helps as a domain independent computational framework for developing knowledge based system for preliminary design as a prelude to the detailed design of mechanical systems